PART L
ATMOSPHERES AND VENTILATION

WAC

WAC 296-62-100 Oxygen deficient atmospheres.

(1) **Definition.** A lack of sufficient oxygen is deemed to exist if the atmosphere at sea level has less than 19.5% oxygen by volume or has a partial pressure of oxygen of 148 millimeters of mercury (mm. Hg) or less. This may deviate when working at higher elevations and should be determined for an individual location. Factors such as acclimatization, physical conditions of the persons involved, etc., must be considered for such circumstances and conditions.

(2) **Entering areas with possible oxygen deficient atmospheres.** Workers entering any area where a lack of sufficient oxygen is probable shall be supplied with and shall use approved equipment (for specific requirements see applicable provisions of chapter 296-62 WAC) capable of providing safe respirable air, or prior to entry and at all times when workers are in such areas a sufficient supply of safe, respirable air shall be provided. All workers so exposed shall be under constant observation. If the oxygen content is unknown or may change during occupation, tests shall be required prior to and during occupation of questionable areas.

[Statutory Authority: Chapter 49.17 RCW. 91-24-017 (Order 91-07), 296-62-100, filed 11/22/91, effective 12/24/91. RCW 49.17.040, 49.17.050, and 49.17.240. 81-16-015 (Order 81-20), 296-62-100, filed 7/27/81; Order 73-3, 296-62-100, filed 5/7/73; Order 70-8, 296-62-100, filed 7/31/70, effective 9/1/70; Rule 10.010, effective 8/1/63.]

WAC 296-62-110 Ventilation.

[Order 73-3, 296-62-110, filed 5/7/73; Order 70-8, 296-62-110, filed 7/31/70, effective 9/1/70; Rules 11.010-11.030, effective 8/1/63.]

WAC 296-62-11001 Definition.

Ventilation shall mean the provision, circulation or exhausting of air into or from an area or space.

(1) **"Local exhaust ventilation"** shall mean the mechanical removal of contaminated air from the point where the contaminant is being generated or liberated.

(2) **"Dilution ventilation"** means inducing and mixing uncontaminated air with contaminated air in such quantities that the resultant mixture in the breathing zone will not exceed the permissible exposure limit (PEL) specified for any contaminant.

WAC 296-62-11001 (Cont.)

(3) **"Exhaust ventilation"** means the general movement of air out of the area or permit-required confined space by mechanical or natural means.

(4) **"Tempered makeup air"** means air which has been conditioned by changing its heat content to obtain a specific desired temperature.

[Statutory Authority: Chapter 49.17 RCW. 95-04-007, 296-62-11001, filed 1/18/95, effective 3/1/95. Statutory Authority: RCW 49.17.040, 49.17.050, 49.17.240, chapters 42.30 and 43.22 RCW. 80-17-014 (Order 80-20), 296-62-11001, filed 11/13/80; Order 73-3, 296-62-11001, filed 5/7/73.]

WAC 296-62-11003 Ventilation guide. In addition to those mandatory controls as set forth in WAC 296-62-11015 through 296-62-11021, the Industrial Ventilation Manual of Recommended Practices as compiled and approved by the American Conference of Governmental Industrial Hygienists, applicable ANSI Standard or other National Consensus Standards recommended by the federal government, should be used as a guide for ventilation requirements.

[Order 73-3, 296-62-11003, filed 5/7/73.]

WAC 296-62-11005 Adequate system. Adequate ventilation systems shall be installed as needed to control concentrations of airborne contaminants below applicable threshold limit values.

[Order 73-3, 296-62-11005, filed 5/7/73.]

WAC 296-62-11007 Exhaust. Exhaust from ventilation systems shall discharge in such a manner that the contaminated air being exhausted will not present a health hazard to any workman or reenter buildings in harmful amounts.

[Order 73-3, 296-62-11007, filed 5/7/73.]

WAC 296-62-11009 Make-up air quantity. Make-up air shall be of ample quantity to replace the exhausted air and shall be tempered when necessary.

[Order 73-3, 296-62-11009, filed 5/7/73.]

WAC 296-62-11011 Design and operation. Ventilation systems shall be designed and operated in such a manner that employees will not be subjected to excessive air velocities.

[Statutory Authority: Chapter 49.17 RCW. 91-11-070 (Order 91-01), 296-62-11011, filed 5/20/91, effective 6/20/91; Order 73-3, 296-62-11011, filed 5/7/73.]

WAC 296-62-11013 Compatibility of systems. Make-up air systems shall be designed and operated in such a manner that they will not interfere with the effectiveness of the exhaust air system.

[Order 73-3, 296-62-11013, filed 5/7/73.]

WAC 296-62-11015 Abrasive blasting. Abrasive blasting is covered in chapter 296-818 WAC, Abrasive blasting.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-12-074 (Order 06-05), § 296-62-11015, filed 06/06/06, effective 09/01/06. Statutory Authority: RCW 49.17.040, [49.17].050 and [49.17].060. 98-02-006, 296-62-11015, filed 12/26/97, effective 3/1/98. Statutory Authority: Chapter 49.17 RCW. 91-24-017 (Order 91-07), 296-62-11015, filed 11/22/91, effective 12/24/91. RCW 49.17.040, 49.17.050, and 49.17.240. 81-16-015 (Order 81-20), 296-62-11015, filed 7/27/81; 80-11-010 (Order 80-14), 296-62-11015, filed 8/8/80; Order 73-3, 296-62-11015, filed 5/7/73.]

WAC 296-62-11017 Grinding, polishing, and buffing operations.

(1) **Definitions.**

(a) **"Abrasive cutting-off wheels"** means organic-bonded wheels, the thickness of which is not more than one forty-eighth of their diameter for those up to, and including, 20 inches in diameter, and not more than one-sixteenth of their diameter for those larger than 20 inches in diameter, used for a multitude of operations variously known as cutting, cutting off, grooving, slotting, coping, jointing, and the like. The wheels may be "solid" consisting of organic-bonded abrasive material throughout, "steel centered" consisting of a steel disc with a rim of organic-bonded material moulded around the periphery or of the "inserted tooth" type consisting of a steel disc with organic-bonded abrasive teeth or inserts mechanically secured around the periphery.

WAC 296-62-11017 (Cont.)

(b) **"Belts"** means all power-driven, flexible, coated bands used for grinding, polishing, or buffing purposes.

(c) **"Branch pipe"** means the part of an exhaust system piping that is connected directly to the hood or enclosure.

(d) **"Cradle"** means a movable fixture, upon which the part to be ground or polished is placed.

(e) **"Disc wheels"** means all power-driven rotatable discs faces with abrasive materials, artificial or natural, and used for grinding or polishing on the side of the assembled disc.

(f) **"Entry loss"** means the loss in static pressure caused by air flowing into a duct or hood. It is usually expressed in inches of water gauge.

(g) **"Exhaust system"** means a system consisting of branch pipes connected to hoods of enclosures, one or more header pipes, an exhaust fan, means for separating solid contaminants from the air flowing in the system, and a discharge stack to outside.

(h) **"Grinding wheels"** means all power-driven rotatable grinding or abrasive wheels, except disc wheels as defined in this standard, consisting of abrasive particles held together by artificial or natural bonds and used for peripheral grinding.

(i) **"Header pipe (main pipe)"** means a pipe into which one or more branch pipes enter and which connects such branch pipes to the remainder of the exhaust system.

(j) **"Hoods and enclosures"** means the partial or complete enclosure around the wheel or disc through which air enters an exhaust system during operation.

(k) **"Horizontal double-spindle disc grinder"** means a grinding machine carrying two power-driven, rotatable, coaxial, horizontal spindles upon the inside ends of which are mounted abrasive disc wheels for grinding two surfaces simultaneously.

(l) **"Horizontal single-spindle disc grinder"** means a grinding machine carrying an abrasive disc wheel upon one or both ends of a power-driven, rotatable single horizontal spindle.

(m) **"Polishing and buffing wheels"** means all power-driven rotatable wheels composed all or in part of textile fabrics, wood, felt, leather, paper, and may be coated with abrasives on the periphery of the wheel for purposes of polishing, buffing, and light grinding.

(n) **"Portable grinder"** means any power-driven rotatable grinding, polishing, or buffing wheel mounted in such manner that it may be manually manipulated.

(o) **"Scratch brush wheels"** means all power-driven rotatable wheels made from wire or bristles, and used for scratch cleaning and brushing purposes.

(p) **"Swing-frame grinder"** means any power-driven rotatable grinding, polishing, or buffing wheel mounted in such a manner that the wheel with its supporting framework can be manipulated over stationary objects.

(q) **"Velocity pressure (vp)"** means the kinetic pressure in the direction of flow necessary to cause a fluid at rest to flow at a given velocity. It is usually expressed in inches of water gauge.

WAC 296-62-11017 (Cont.)

(r) **"Vertical spindle disc grinder"** means a grinding machine having a vertical, rotatable power-driven spindle carrying a horizontal abrasive disc wheel.

(2) **Application.**

(a) Every establishment performing dry grinding, dry polishing, or buffing shall provide suitable hood or enclosures that are connected to exhaust systems.

(b) Such exhaust systems shall be operated continuously whenever such operations are carried on, and be capable of preventing contaminants from entering the breathing zone.

(3) **Hood and branch pipe requirements.**

(a) Hoods connected to exhaust systems shall be used, and such hoods shall be designed, located, and placed so that the dust or dirt particles shall fall or be projected into the hoods in the direction of the air flow. No wheels, discs, straps, or belts shall be operated in such manner and in such direction as to cause the dust and dirt particles to be thrown into the operator's breathing zone.

(b) Grinding wheels on floor stands, pedestals, benches, and special-purpose grinding machines and abrasive cutting-off wheels shall have not less than the minimum exhaust volumes shown in Table 8 with a recommended minimum duct velocity of 4,500 feet per minute in the branch and 3,500 feet per minute in the main. The entry losses from all hoods except the vertical-spindle disc grinder hood, shall equal 0.65 velocity pressure for a straight takeoff and 0.45 velocity pressure for a tapered takeoff. The entry loss for the vertical-spindle disc grinder hood is shown in Figure 3. (See Fig. 3 following this section.)

TABLE 8
GRINDING AND ABRASIVE CUTTING

Wheel diameter (inches)	Wheel width (inches)	Minimum exhaust volume (feet ^{3}/min.)
To 9	1 1/2	220
Over 9 to 16	2	390
Over 16 to 19	3	500
Over 19 to 24	4	610
Over 24 to 30	5	880
Over 30 to 36	6	1,200

For any wheel wider than wheel diameter shown in Table 8, increase the exhaust volume by the ratio of the new width to the width shown.

Example:

If wheel width = 4 1/2 inches, then

$$\frac{4.5}{4} \times 610 = 686 \text{ (rounded to 690).}$$

(c) Scratch-brush wheels and all buffing and polishing wheels mounted on floor stands, pedestals, benches, or special-purpose machines shall have not less than the minimum exhaust volume shown in Table 9.

WAC 296-62-11017 (Cont.)

TABLE 9 BUFFING AND POLISHING WHEELS		
Wheel diameter (inches)	**Wheel width (inches)**	**Minimum exhaust volume (feet ^{3}/min.)**
To 9	2	300
Over 9 to 16	3	500
Over 16 to 19	4	610
Over 19 to 24	5	740
Over 24 to 30	6	1,040
Over 30 to 36	6	1,200

(d) Grinding wheels or discs for horizontal single-spindle disc grinders shall be hooded to collect the dust or dirt generated by the grinding operation and the hoods shall be connected to branch pipes having exhaust volumes as shown in Table 10.

TABLE 10 HORIZONTAL SINGLE-SPINDLE DISC GRINDER	
Disc diameter (inches)	**Exhaust volume (feet^3/min.)**
Up to 12	220
Over 12 to 19	390
Over 19 to 30	610
Over 30 to 36	880

(e) Grinding wheels or discs for horizontal double-spindle disc grinders shall have a hood enclosing the grinding chamber and the hood shall be connected to one or more branch pipes having exhaust volumes as shown in Table 11.

TABLE 11 HORIZONTAL DOUBLE-SPINDLE DISC GRINDER	
Disc diameter (inches)	**Exhaust volume (feet^3/min.)**
Up to 19	610
Over 19 to 25	880
Over 25 to 30	1,200
Over 30 to 53	1,770
Over 53 to 72	6,280

(f) Grinding wheels or discs for vertical single-spindle disc grinders shall be encircled with hoods to remove the dust generated in the operation. The hoods shall be connected to one or more branch pipes having exhaust volumes as shown in Table 12.

TABLE 12 VERTICAL SPINDLE DISC GRINDER				
Disc diameter (inches)	**One-half or more of disc covered**		**Disc not covered**	
	Number[1]	**Exhaust feet^3/min**	**Number[1]**	**Exhaust feet^3/min**
Up to 20	1	500	2	780
Over 20 to 30	2	780	2	1,480
Over 30 to 53	2	1,770	4	3,530
Over 53 to 72	2	3,140	5	6,010

WAC 296-62-11017 (Cont.)

[1] Number of exhaust outlets around periphery of hood, or equal distribution provided by other means.

(g) Grinding and polishing belts shall be provided with hoods to remove dust and dirt generated in the operations and the hoods shall be connected to branch pipes having exhaust volumes as shown in Table 13.

TABLE 13
GRINDING AND POLISHING BELTS

Belts width (inches)	Exhaust volume ($feet^3$/min.)
Up to 3	220
Over 3 to 5	300
Over 5 to 7	390
Over 7 to 9	500
Over 9to 11	610
Over 11 to 13	740

(h) Cradles and swing-frame grinders. Where cradles are used for handling the parts to be ground, polished, or buffed, requiring large partial enclosures to house the complete operation, a minimum average air velocity of 150 feet per minute shall be maintained over the entire opening of the enclosure. Swing-frame grinders shall also be exhausted in the same manner as provided for cradles. (See Fig. 5 following this section.)

(i) Where the work is outside the hood, air volumes must be increased as shown in American Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, Z9.2-1960 (Section 4, Exhaust Hoods).

(4) **Exhaust systems.**

(a) Exhaust systems for grinding, polishing, and buffing operations should be designed in accordance with American Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, Z9.2-1960.

(b) Exhaust systems for grinding, polishing, and buffing operations shall be tested in the manner described in American Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, Z9.2-1960.

(c) All exhaust systems shall be provided with suitable dust collectors.

(5) **Hood and enclosure design.**

(a)(i) It is the dual function of grinding and abrasive cutting-off wheel hoods to protect the operator from the hazards of bursting wheels as well as to provide a means for the removal of dust and dirt generated. All hoods shall be not less in structural strength than specified in the American National Standard Code for the Use, Care, and Protection of Abrasive Wheels, B7.1-1970.

(ii) For grinding machines for which no standard hoods are available, hoods meeting the requirements of (5)(a)(i) above shall be developed and so located so as to comply with the requirements of this section.

WAC 296-62-11017 (Cont.)

(b) Exhaust hoods for floor stands, pedestals, and bench grinders shall be designed in accordance with Figure 4. (See Fig. 4 following this section.) The adjustable tongue shown in the figure shall be kept in working order and shall be adjusted within one-fourth inch of the wheel periphery at all times.

(c) Swing-frame grinders shall be provided with exhaust booths as indicated in Figure 5. (See Fig. 5 following this section.)

(d) Portable grinding operations, whenever the nature of the work permits, shall be conducted within a partial enclosure. The opening in the enclosure shall be no larger than is actually required in the operation and an average face air velocity of not less than 200 feet per minute shall be maintained.

(e) Hoods for polishing and buffing and scratch-brush wheels shall be constructed to conform as closely to Figure 6 as the nature of the work will permit. (See Fig. 6 following this section.)

(f) Cradle grinding and polishing operations shall be performed within a partial enclosure similar to Figure 7. (See Fig. 7 following this section.) The operator shall be positioned outside the working face of the opening of the enclosure. The face opening of the enclosure should not be any greater in area than that actually required for the performance of the operation and the average air velocity into the working face of the enclosure shall not be less than 150 feet per minute.

(g) Hoods for horizontal single-spindle disc grinders shall be constructed to conform as closely as possible to the hood shown in Figure 8. (See Fig. 8 following this section.) It is essential that there be a space between the back of the wheel and the hood, and a space around the periphery of the wheel of at least 1 inch in order to permit the suction to act around the wheel periphery. The opening on the side of the disc shall be no larger than is required for the grinding operation, but must never be less than twice the area of the branch outlet.

(h) Horizontal double-spindle disc grinders shall have a hood encircling the wheels and grinding chamber similar to that illustrated in Figure 9. (See Fig. 9 following this section.) The openings for passing the work into the grinding chamber should be kept as small as possible, but must never be less than twice the area of the branch outlets.

(i) Vertical-spindle disc grinders shall be encircled with a hood so constructed that the heavy dust is drawn off a surface of the disc and the lighter dust exhausted through a continuous slot at the top of the hood as shown in Figure 3. (See Fig. 3 following this section.)

(j) Grinding and polishing belt hoods shall be constructed as close to the operation as possible. The hood should extend almost to the belts, and 1-inch wide openings should be provided on either side. Figure 10 shows a typical hood for a belt operation. (See Fig. 10 following this section.)

(6) **Scope.** This paragraph, prescribes the use of exhaust hood enclosures and systems in removing dust, dirt, fumes, and gases generated through the grinding, polishing, or buffing of ferrous and nonferrous metals.

WAC 296-62-11017 (Cont.)

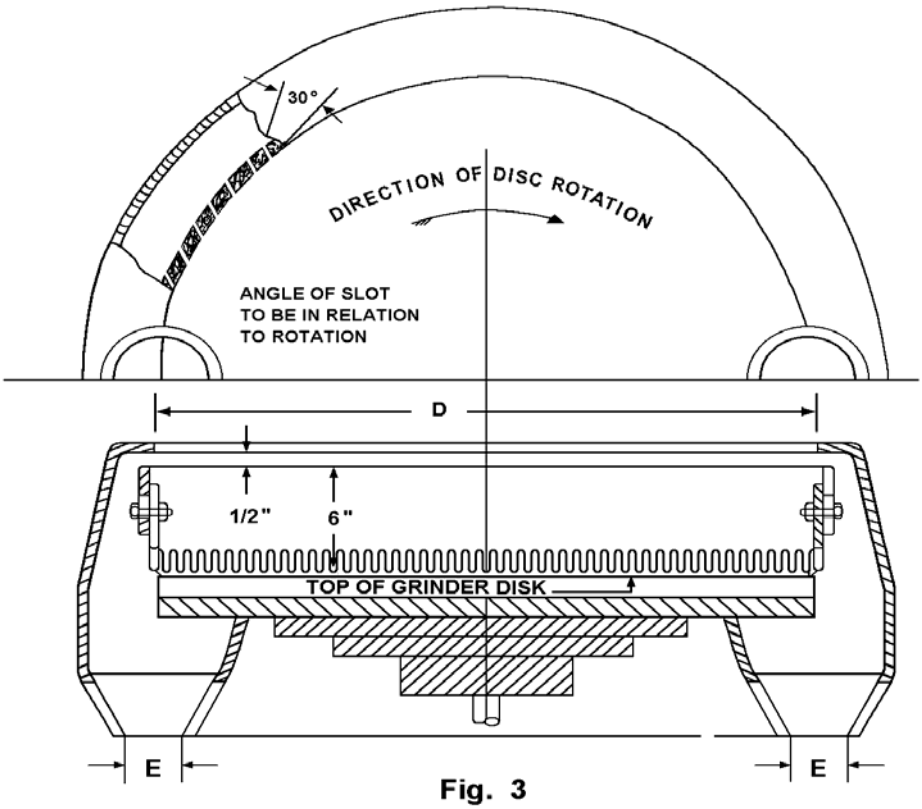

Fig. 3

Vertical Spindle Disc Grinder Exhaust Hood and Branch Pipe Connections

Dia D. Inches		Exhaust E		Volume Exhausted	
		No.		at 4,500 ft/min	
Min.	Max	Pipes	Dia	ft^3/min	Note
	20	1	4 1/2	500	When one-half or more of the disc can be hooded, use exhaust ducts as shown at the left.
Over 20	30	2	4	780	
Over 30	72	2	6	1,770	
Over 53	72	2	8	3,140	
	20	2	4	780	When no hood can be used over disc, use exhaust ducts as shown at left.
Over 20	30	2	5 1/2	1,480	
Over 30	53	4	6	3,530	
Over 53	72	5	7	6,010	

Entry loss = 1.0 slot velocity pressure + 0.5 branch velocity pressure
Minimum slot velocity = 2,000 ft/min - 1/2-inch slot width

WAC 296-62-11017 (Cont.)

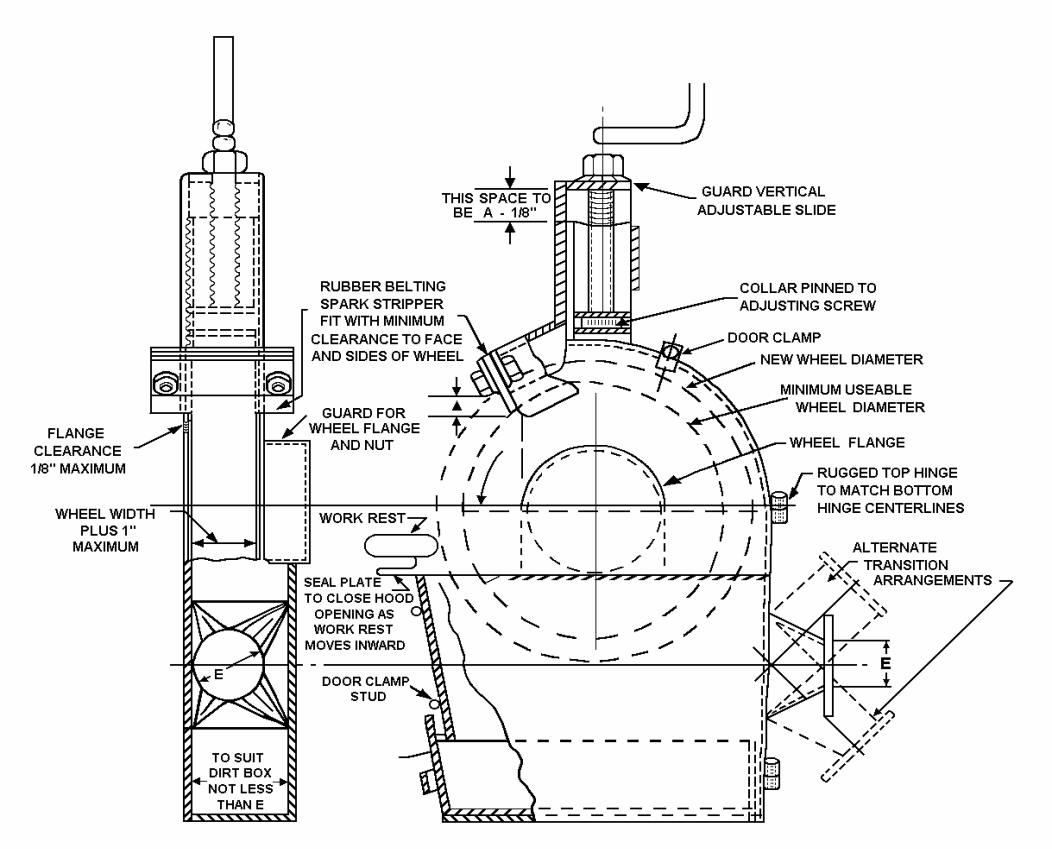

Fig. 4
Standard Grinder Hood

TABLE 10 HORIZONTAL SINGLE-SPINDLE DISC GRINDER				
Wheel dimension inches Diameter		**Width**	**Exhaust Outlet,**	**Volume of Air at**
Min = d	**Max = D**	**Max**	**Inches E**	**4,500 ft/min**
	9	1 1/2	3	220
Over 9	16	2	4	390
Over 16	19	3	4 1/2	500
Over 19	24	4	5	610
Over 24	30	5	6	880
Over 30	36	6	7	1.200

Entry loss = 0.45 velocity pressure for tapered takeoff
0.65 velocity pressure for straight takeoff

WAC 296-62-11017 (Cont.)

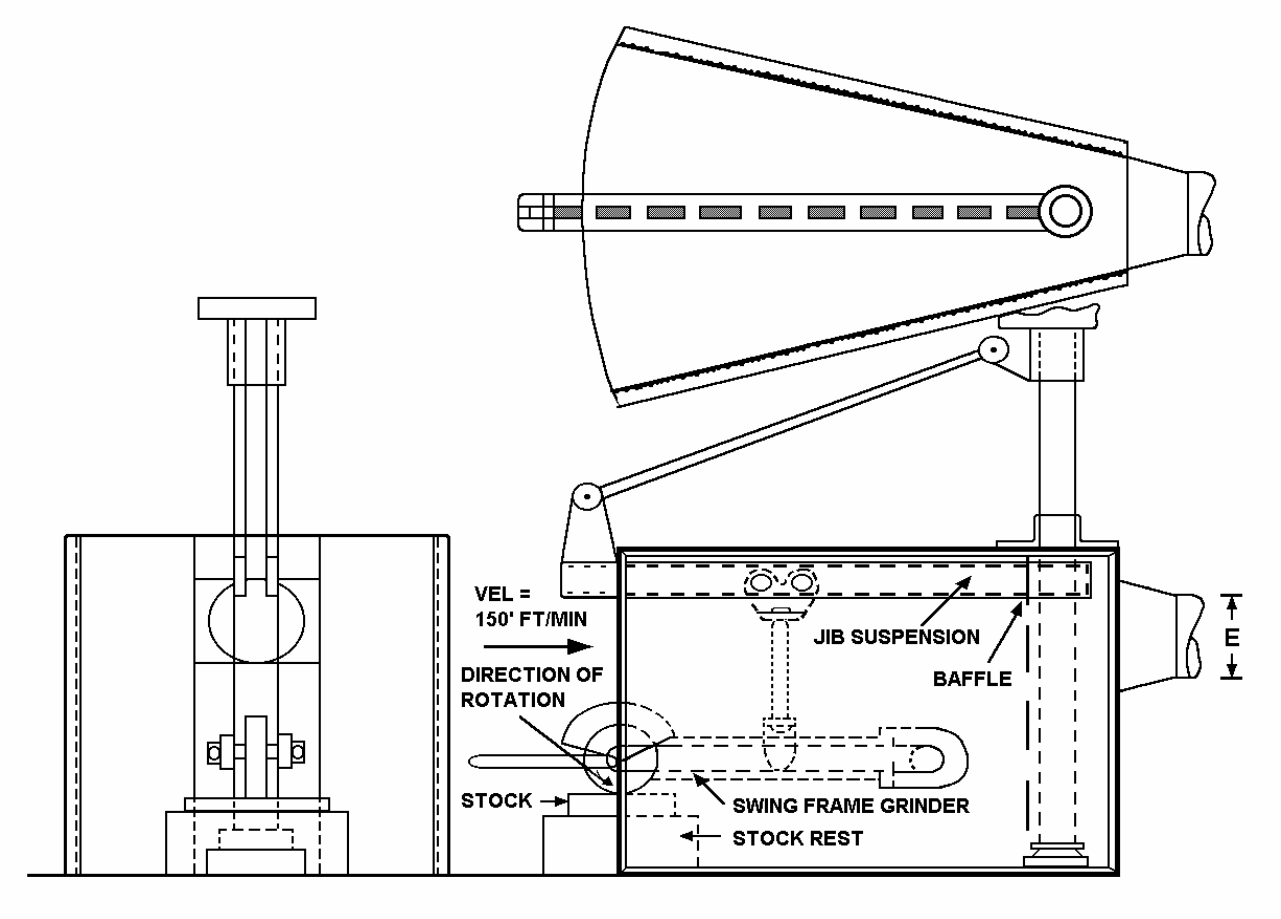

Fig. 5
A Method of Applying an Exhaust Enclosure to Swing-Frame Grinders
NOTE: Baffle to reduce front opening as much as possible

WAC 296-62-11017 (Cont.)

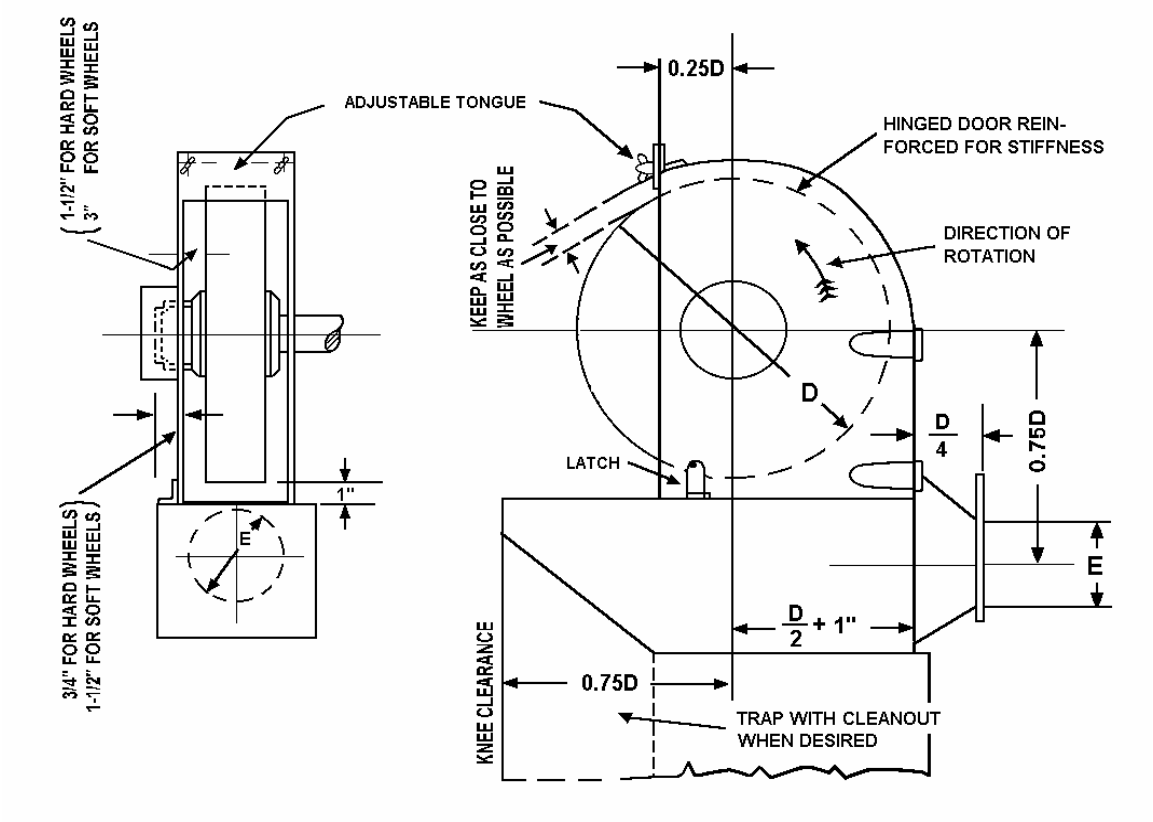

Fig. 6
Standard Buffing and Polishing Hood

Wheel dimension inches Diameter Min = d	Max = D	Width Max	Exhaust Outlet, Inches E	Volume of Air at 4,500 ft/min
	9	2	3 1/2	300
Over 9	16	3	4	500
Over 16	19	4	5	610
Over 19	24	5	5 1/2	740
Over 24	30	6	6 1/2	1,040
Over 30	36	6	7	1,200

Entry loss = 0.45 velocity pressure for tapered takeoff
0.65 velocity pressure for straight takeoff

WAC 296-62-11017 (Cont.)

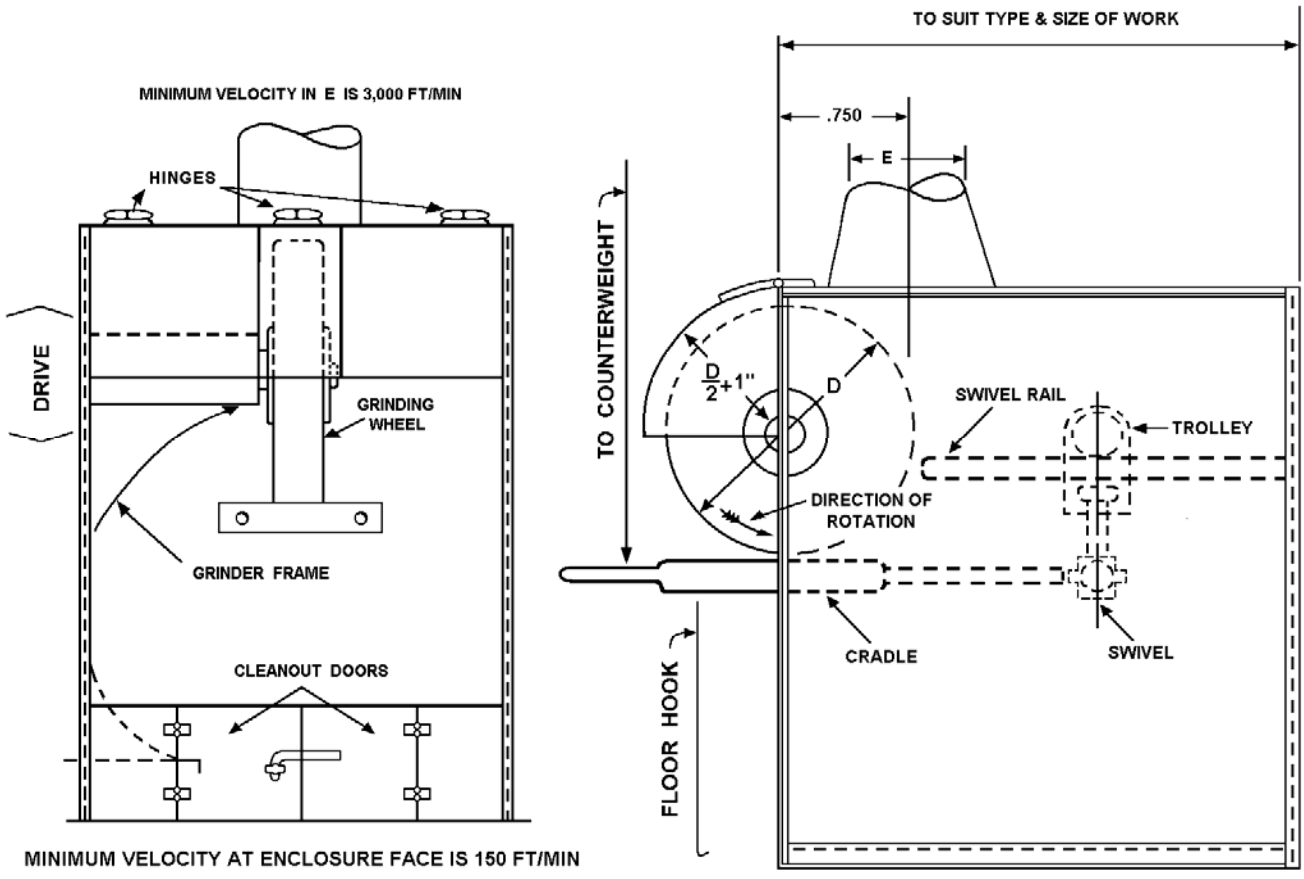

Fig. 7
Cradle Polishing or Grinding Enclosure
Entry loss = 0.45 velocity pressure for tapered takeoff

WAC 296-62-11017 (Cont.)

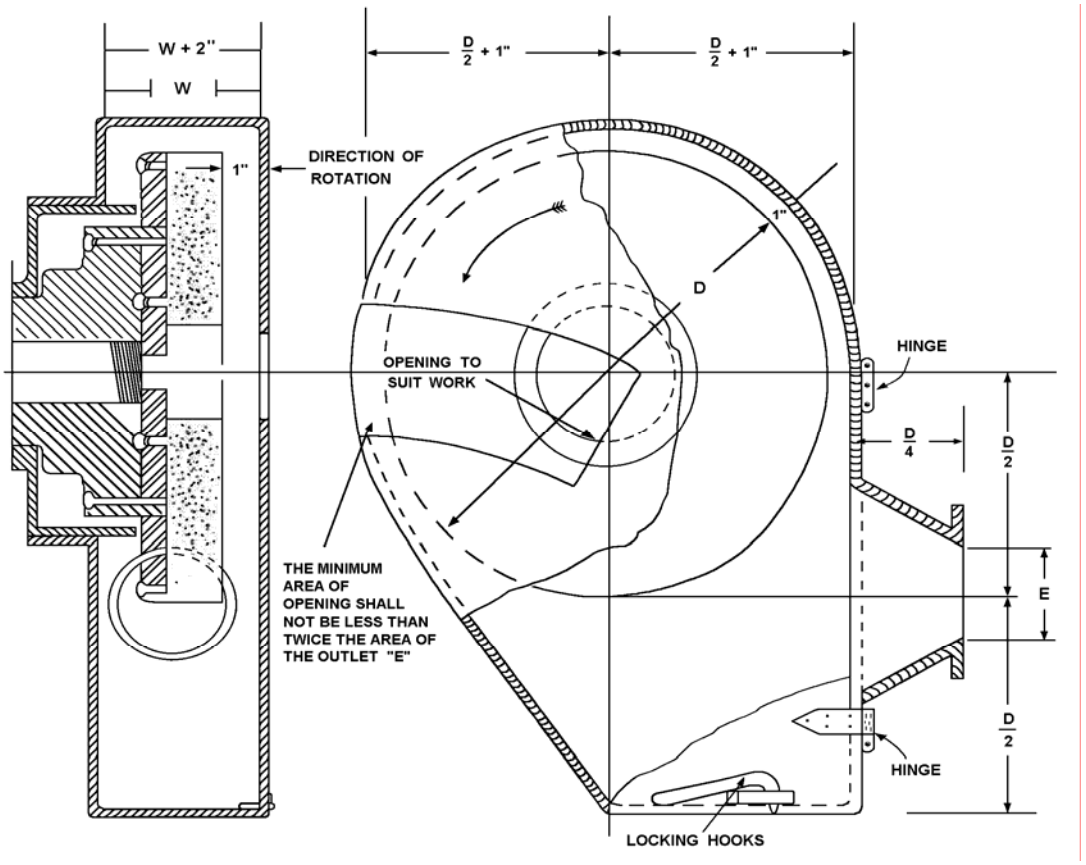

Fig. 8
Horizontal Single-Spindle Disc Grinder
Exhaust Hood and Branch Pipe Connection

Dia. D. Inches		Exhaust E	Volume of air at
Min	Max	Dia. Inches	4,500 ft/min
	12	3	220
Over 12	19	4	390
Over 19	30	5	610
Over 30	36	6	880

Note: *If grinding wheels are used for disc grinding purposes, hoods must conform to structural strength and materials as described in 9.1.*
Entry loss = 0.45 velocity pressure for tapered takeoff

WAC 296-62-11017 (Cont.)

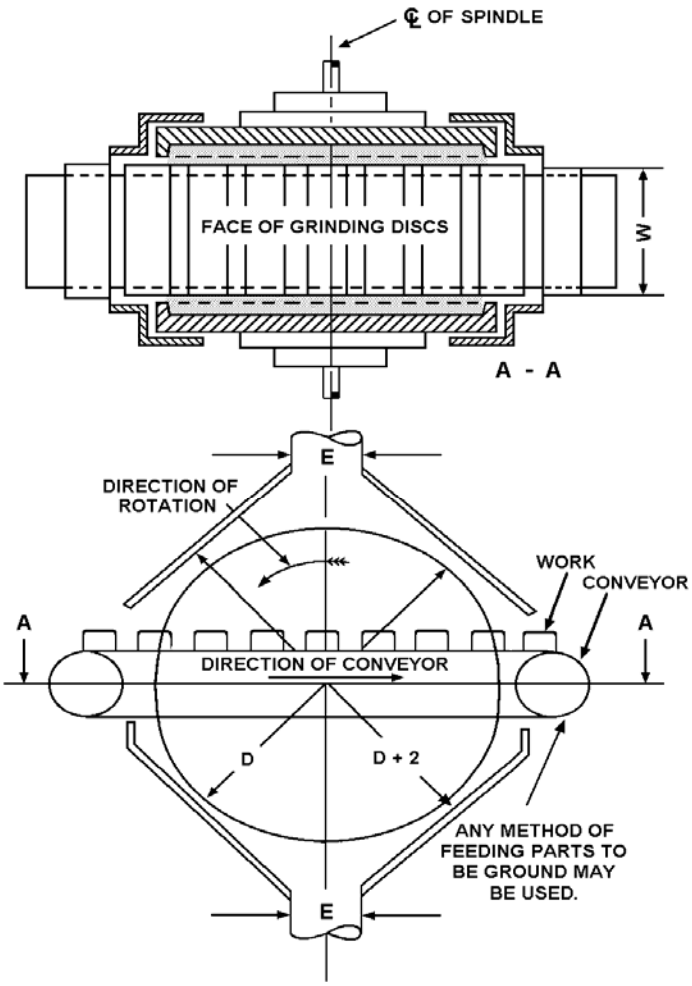

Fig. 9
Horizontal Double-Spindle Disc Grinder
Exhaust Hood and Branch Pipe Connection

Dia D. Inches		Exhaust E No.		Volume Exhausted at 4,500 ft/min.	Note
Min.	Max	Pipes	Dia	ft^3/min	
	19	1	5	610	When width "W" permits, exhaust ducts should be near heaviest grinding as possible.
Over 19	25	1	6	880	
Over 25	30	1	7	1,200	
Over 30	53	2	6	1,770	
Over 72	72	4	8	6,280	

Entry loss = 0.45 velocity pressure for tapered takeoff

WAC 296-62-11017 (Cont.)

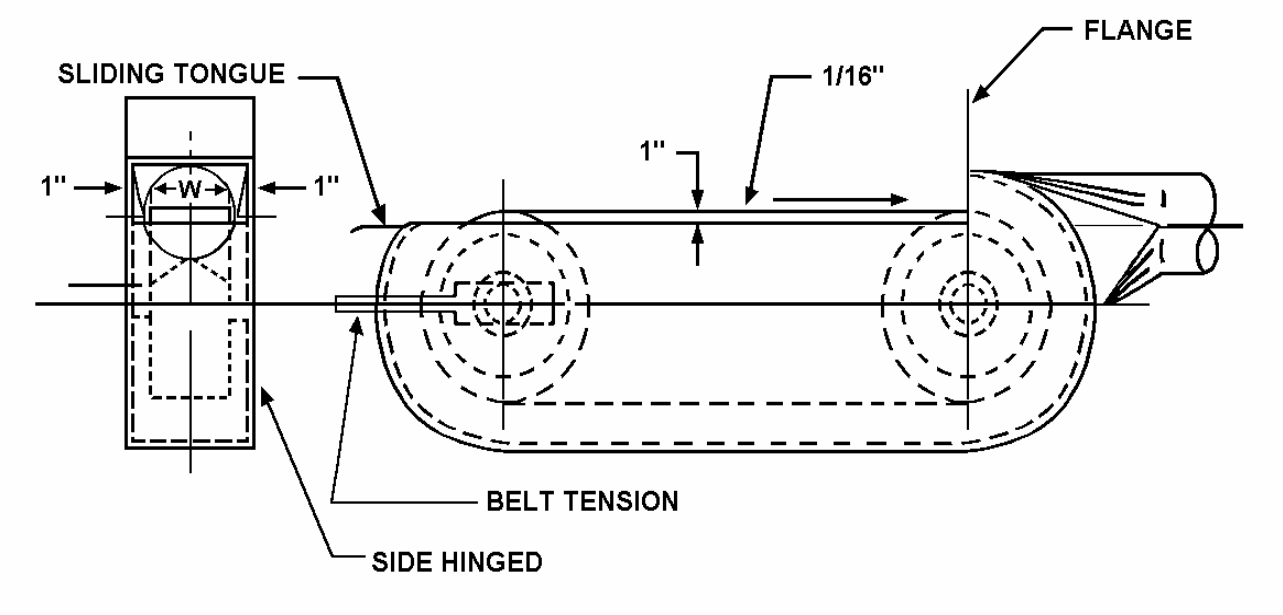

Figure 10
A Typical Hood for a Belt Operation

Belt Width w. Inches	Exhaust Volume ft^3/min.
Up to 3	220
3 to 5	300
5 to 7	390
7 to 9	500
9 to 11	610
11 to 13	740

Minimum duct velocity = 4.500 ft./min. branch.
3.500 ft./min. main.

Entry loss = 0.45 velocity pressure for tapered takeoff
0.65 velocity pressure for straight takeoff

[Order 73-3, 296-62-11017 and diagrams, filed 5/7/73.]

WAC 296-62-11019 Spray-finishing operations.

(1) **Definitions.**

(a) **"Spray-finishing operations"** means employment of methods wherein organic or inorganic materials are utilized in dispersed form from deposit on surfaces to be coated, treated or cleaned. Such methods of deposit may involve either automatic, manual, or electrostatic deposition but do not include metal spraying or metallizing, dipping, flow coating, roller coating, tumbling, centrifuging, or spray washing and degreasing as conducted in self-contained washing and degreasing machines or systems.

(b) **"Spray booth"** spray booths are defined and described in WAC 296-24-370 through 296-24-37007. (See sections 103, 104, and 105 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.)

WAC 296-62-11019 (Cont.)

(c) **"Spray room"** means a room in which spray-finishing operations not conducted in a spray booth are performed separately from other areas.

(d) **"Minimum maintained velocity"** means the velocity of air movement which must be maintained in order to meet minimum specified requirements for health and safety.

(2) **Location and application.** Spray booths or spray rooms are to be used to enclose or confine all operations. Spray-finishing operations shall be located as provided in sections 201 through 206 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.

(3) **Design and construction of spray booths.**

(a) Spray booths shall be designed and constructed in accordance with WAC 296-24-370 through 296-24-37007 (see sections 301-304 and 306-310 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969), for general construction specifications.

Note: For a more detailed discussion of fundamentals relating to this subject, see ANSI Z9.2-1960.

(i) Lights, motors, electrical equipment and other sources of ignition shall conform to the requirements of WAC 296-24-370. (See section 310 and chapter 4 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.)

(ii) In no case shall combustible material be used in the construction of a spray booth and supply or exhaust duct connected to it.

(b) Unobstructed walkways shall not be less than 6 1/2 feet high and shall be maintained clear of obstruction from any work location in the booth to a booth exit or open booth front. In booths where the open front is the only exit, such exits shall be not less than 3 feet wide. In booths having multiple exits, such exits shall not be less than 2 feet wide, provided that the maximum distance from the work location to the exit is 25 feet or less. Where booth exits are provided with doors, such doors shall open outward from the booth.

(c) Baffles, distribution plates, and dry-type overspray collectors shall conform to the requirements of WAC 296-24-370. (See sections 304 and 305 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.)

(i) Overspray filters shall be installed and maintained in accordance with the requirements of WAC 296-24-370, (See section 305 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969), and shall only be in a location easily accessible for inspection, cleaning, or replacement.

(ii) Where effective means, independent of the overspray filters are installed which will result in design air distribution across the booth cross section, it is permissible to operate the booth without the filters in place.

(d)(i) For wet or water-wash spray booths, the water-chamber enclosure, within which intimate contact of contaminated air and cleaning water or other cleaning medium is maintained, if made of steel, shall be 18 gauge or heavier and adequately protected against corrosion.

WAC 296-62-11019 (Cont.)

(ii) Chambers may include scrubber spray nozzles, headers, troughs, or other devices. Chambers shall be provided with adequate means for creating and maintaining scrubbing action for removal of particulate matter from the exhaust air stream.

(e) Collecting tanks shall be of welded steel construction or other suitable noncombustible material. If pits are used as collecting tanks, they shall be concrete, masonry, or other material having similar properties.

(i) Tanks shall be provided with weirs, skimmer plates, or screens to prevent sludge and floating paint from entering the pump suction box. Means for automatically maintaining the proper water level shall also be provided. Fresh water inlets shall not be submerged. They shall terminate at least one pipe diameter above the safety overflow level of the tank.

(ii) Tanks shall be so constructed as to discourage accumulation of hazardous deposits.

(f) Pump manifolds, risers, and headers shall be adequately sized to insure sufficient water flow to provide efficient operation of the water chamber.

(4) **Design and construction of spray rooms.**

(a) Spray rooms, including floors, shall be constructed of masonry, concrete, or other noncombustible material.

(b) Spray rooms shall have noncombustible fire doors and shutters.

(c) Spray rooms shall be adequately ventilated so that the atmosphere in the breathing zone of the operator shall be maintained in accordance with the requirements of (6)(b) of this section.

(d) Spray rooms used for production spray-finishing operations shall conform to the requirements of spray booths.

(5) **Ventilation.**

(a) Ventilation shall be provided in accordance with provisions of WAC 296-24-370, (See chapter 5 of the Standard for Spray Finishing Using Flammable or Combustible Materials, NFPA No. 33-1969), and in accordance with the following:

(i) Where a fan plenum is used to equalize or control the distribution of exhaust air movement through the booth, it shall be of sufficient strength or rigidity to withstand the differential air pressure or other superficially imposed loads for which the equipment is designed and also to facilitate cleaning. Construction specifications shall be at least equivalent to those of (5)(c) of this section.

(ii) All fan ratings shall be in accordance with Air Moving and Conditioning Association Standard Test Code for Testing Air Moving Devices, Bulletin 210, April 1962.

(b) Inlet or supply ductwork used to transport makeup air to spray booths or surrounding areas shall be constructed of noncombustible materials.

(i) If negative pressure exists within inlet ductwork, all seams and joints shall be sealed if there is a possibility of infiltration of harmful quantities of noxious gases, fumes, or mists from areas through which ductwork passes.

WAC 296-62-11019 (Cont.)

(ii) Inlet ductwork shall be sized in accordance with volume flow requirements and provide design air requirements at the spray booth.

(iii) Inlet ductwork shall be so supported throughout its length to sustain at least its own weight plus any negative pressure which is exerted upon it under normal operating conditions.

(c) Ducts shall be so constructed as to provide structural strength and stability at least equivalent to sheet steel of not less than the following thickness:

DIAMETER OR GREATER DIMENSION	
	(U.S. gauge)
Up to 8 inches inclusive	No. 24
Over 8 inches to 18 inches inclusive	No. 22
Over 18 inches to 30 inches inclusive	No. 20
Over 30 inches	No. 18

(i) Exhaust ductwork shall be adequately supported throughout its length to sustain its weight plus any normal accumulation in interior during normal operating conditions and any negative pressure exerted upon it.

(ii) Exhaust ductwork shall be sized in accordance with good design practice which shall include consideration of fan capacity, length of duct, number of turns and elbows, variation in size, volume, and character of materials being exhausted. See American National Standard Z9.2-1960 for further details and explanation concerning elements of design.

(iii) Longitudinal joints in sheet steel ductwork shall be either lock-seamed, riveted, or welded. For other than steel construction, equivalent securing of joints shall be provided.

(iv) Circumferential joints in ductwork shall be substantially fastened together and lapped in the direction of airflow. At least every fourth joint shall be provided with connecting flanges, bolted together or of equivalent fastening security.

(v) Inspection or clean-out doors shall be provided for every 9 to 12 feet of running length for ducts up to 12 inches in diameter, but the distance between clean-out doors may be greater for larger pipes. (See 8.3.21 of American National Standard Z9.1-1960.) A clean-out door or doors shall be provided for servicing the fan, and where necessary, a drain shall be provided.

(vi) Where ductwork passes through a combustible roof or wall, the roof or wall shall be protected at the point of penetration by open space or fire-resistive material between the duct and the roof or wall. When ducts pass through fire-walls, they shall be provided with automatic fire dampers on both sides of the wall, except that three-eighth-inch steel plates may be used in lieu of automatic fire dampers for ducts not exceeding 18 inches in diameter.

(vii) Ductwork used for ventilating any process covered in this standard shall not be connected to ducts ventilating any other process or any chimney or flue used for conveying any products of combustion.

WAC 296-62-11019 (Cont.)

(6) **Velocity and air flow requirements.**

(a) Except where a spray booth has an adequate air replacement system, the velocity of air into all openings of a spray booth shall be not less than that specified in Table 14 for the operating conditions specified. An adequate air replacement system is one which introduces replacement air upstream or above the object being sprayed and is so designed that the velocity of air in the booth cross section is not less than that specified in Table 14 when measured upstream or above the object being sprayed.

Table 14
Minimum Maintained Velocities into Spray Booths

Operating Airflow conditions For object Completely inside booth	**Crossdraft f.p.m.**	**Airflow Velocities f.p.m.**	
		Design	**Range**
Electrostatic and automatic airless operation contained in booth without operator.	Negligible	50 large booth 100 small booth	50-75 75-125
Air-operated guns, manual or automatic	Up to 50	100 large booth 150 small booth	75-125 125-175
Air-operated guns, manual or automatic	Up to 100	150 large booth 200 small booth	125-175 150-250

Notes:

(1) Attention is invited to the fact that the effectiveness of the spray booth is dependent upon the relationship of the depth of the booth to its height and width.

(2) Crossdrafts can be eliminated through proper design and such design should be sought. Crossdrafts in excess of 100 fpm (feet per minute) should not be permitted.

(3) Excessive air pressures result in loss of both efficiency and material waste in addition to creating a backlash that may carry overspray and fumes into adjacent work areas.

(4) Booths should be designed with velocity shown in the column headed "Design." However, booths operating with velocities shown in the column headed "Range" are in compliance with this standard.

(b) In addition to the requirements in (6)(a) of this section the total air volume exhausted through a spray booth shall be such as to dilute solvent vapor to at least 25 percent of the lower explosive limit of the solvent being sprayed. An example of the method of calculating this volume is given below.

Example: *To determine the lower explosive limits of the most common solvents used in spray finishing, see Table 15. Column 1 gives the number of cubic feet of vapor per gallon of solvent and column 2 gives the lower explosive limit (LEL) in percentage by volume of air. Note that the quantity of solvent will be diminished by the quantity of solids and nonflammable contained in the finish.*

To determine the volume of air in cubic feet necessary to dilute the vapor from 1 gallon of solvent to 25 percent of the lower explosive limit, apply the following formula:

WAC 296-62-11019 (Cont.)

$$\text{Dilution volume required per gallon of solvent} = \frac{4\,(100-\text{LEL})\,(\text{cubic feet of vapor per gallon})}{\text{LEL}}$$

Using toluene as the solvent.

(1) LEL of toluene from Table 15, column 2, is 1.4 percent.

(2) Cubic feet of vapor per gallon from Table 15, column 1, is 30.4 cubic feet per gallon.

(3) Dilution volume required =

$$\frac{4\,(100-1.4)\,30.4}{1.4} = 8{,}564 \text{ cubic feet.}$$

(4) To convert to cubic feet per minute of required ventilation, multiply the dilution volume required per gallon of solvent by the number of gallons of solvent evaporated per minute.

WAC 296-62-11019 (Cont.)

TABLE 15 LOWER EXPLOSIVE LIMIT OF SOME COMMONLY USED SOLVENTS		
Solvent	**Cubic feet of vapor per gallon of liquid at 70°F.**	**Lower explosive limit in percent by volume of air at 70°F.**
	Column 1	Column 2
Acetone	44.0	2.6
Amyl Acetate (iso)	21.6	1.0*
Amyl Alcohol (n)	29.6	1.2
Amyl Alcohol (iso)	29.6	1.2
Benzene	36.8	1.4*
Butyl Acetate (n)	24.8	1.7
Butyl Alcohol (n)	35.2	1.4
Butyl Cellosolve	24.8	1.1
Cellosolve	33.6	1.8
Cellosolve Acetate	23.2	1.7
Cyclohexanone	31.2	1.1*
1,1 Dichloroethylene	42.4	5.6
1,2 Dichloroethylene	42.4	9.7
Ethyl Acetate	32.8	2.5
Ethyl Alcohol	55.2	4.3
Ethyl Lactate	28.0	1.5*
Methyl Acetate	40.0	3.1
Methyl Alcohol	80.8	7.3
Methyl Cellosolve	40.8	2.5
Methyl Ethyl Ketone	36.0	1.8
Methyl n-Propyl Ketone	30.4	1.5
Naphtha (VM&P) (76° Naphtha) Naphtha (100° Flash)	22.4	0.9
Safety solvent-Stoddard Solvent	23.2	1.1
Propyl Acetate(n)	27.2	2.0
Propyl Acetate (iso)	28.0	1.8
Propyl Alcohol (n)	44.8	2.1
Propyl Alcohol (iso)	44.0	2.0
Toluene	30.4	1.4
Turpentine	20.8	0.8
Xylene (o)	26.4	1.0

* At 212°F

WAC 296-62-11019 (Cont.)

(c)(i) When an operator is in a booth downstream of the object being sprayed, an air-supplied respirator or other type of respirator certified by NIOSH under 42 CFR part 84 for the material being sprayed should be used by the operator.

(ii) Where downdraft booths are provided with doors, such doors shall be closed when spray painting.

(7) **Make-up air.**

(a) Clean fresh air, free of contamination from adjacent industrial exhaust systems, chimneys, stacks, or vents, shall be supplied to a spray booth or room in quantities equal to the volume of air exhausted through the spray booth.

(b) Where a spray booth or room receives make-up air through self-closing doors, dampers, or louvers, they shall be fully open at all times when the booth or room is in use for spraying. The velocity of air through such doors, dampers, or louvers shall not exceed 200 feet per minute. If the fan characteristics are such that the required air flow through the booth will be provided, higher velocities through the doors, dampers, or louvers may be used.

(c)(i) Where the air supply to a spray booth or room is filtered, the fan static pressure shall be calculated on the assumption that the filters are dirty to the extent that they require cleaning or replacement.

(ii) The rating of filters shall be governed by test data supplied by the manufacturer of the filter. A pressure gauge shall be installed to show the pressure drop across the filters. This gauge shall be marked to show the pressure drop at which the filters require cleaning or replacement. Filters shall be replaced or cleaned whenever the pressure drop across them becomes excessive or whenever the air flow through the face of the booth falls below that specified in Table 14.

(d)(i) Means of heating make-up air to any spray booth or room, before or at the time spraying is normally performed, shall be provided in all places where the outdoor temperature may be expected to remain below 55° F. for appreciable periods of time during the operation of the booth except where adequate and safe means of radiant heating for all operating personnel affected is provided. The replacement air during the heating seasons shall be maintained at not less than 65° F. at the point of entry into the spray booth or spray room. When otherwise unheated make-up air would be at a temperature of more than 10° F. below room temperature, its temperature shall be regulated as provided in section 3.6 of ANSI Z9.2-1960.

(ii) As an alternative to an air replacement system complying with the preceding section, general heating of the building in which the spray room or booth is located may be employed provided that all occupied parts of the building are maintained at not less than 65° F. when the exhaust system is in operation or the general heating system supplemented by other sources of heat may be employed to meet this requirement.

(iii) No means of heating make-up air shall be located in a spray booth.

(iv) Where make-up air is heated by coal or oil, the products of combustion shall not be allowed to mix with the make-up air, and the products of combustion shall be conducted outside the building through a flue terminating at a point remote from all points where make-up air enters the building.

WAC 296-62-11019 (Cont.)

(v) Where make-up air is heated by gas, and the products of combustion are not mixed with the make-up air but are conducted through an independent flue to a point outside the building remote from all points where make-up air enters the building, it is not necessary to comply with (7)(d)(vi) of this section.

(vi) Where make-up air to any manually operated spray booth or room is heated by gas and the products of combustion are allowed to mix with the supply air, the following precautions must be taken:

(A) The gas must have a distinctive and strong enough odor to warn workmen in a spray booth or room of its presence if in an unburned state in the make-up air.

(B) The maximum rate of gas supply to the make-up air heater burners must not exceed that which would yield in excess of 200 p.p.m. (parts per million) of carbon monoxide or 2,000 p.p.m. of total combustible gases in the mixture if the unburned gas upon the occurrence of flame failure were mixed with all of the make-up air supplied.

(C) A fan must be provided to deliver the mixture of heated air and products of combustion from the plenum chamber housing the gas burners to the spray booth or room.

(8) **Scope.** Spray booths or spray rooms are to be used to enclose or confine all spray finishing operations covered by this paragraph. This paragraph does not apply to the spraying of the exteriors of buildings, fixed tanks, or similar structures, nor to small portable spraying apparatus not used repeatedly in the same location.

[Statutory Authority: RCW 49.17.010, .040, .050. 99-10 (Order 98-10) § 296-62-11019, filed 05/04/99, effective 09/01/99.] Statutory Authority: RCW 49.17.040, 49.17.050, and 49.17.240. 81-16-015 (Order 81-20), 296-62-11019, filed 7/27/81; Order 73-3, 296-62-11019, filed 5/7/73.]